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Some Production Aspects and Stock Level Results of the MATERIEL REPAIR SYSTEM

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MATERIEL REPAIR SYSTEM

by

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TABLE OF CONTENTS

FIGURES

ABSTRACT

This is a supplement to "An Operations Analysis of the Materiel Repair System." It examines some production aspects and stock level results of the Materiel Repair System (MRS) during the first half of Fiscal Year 1959. The basic report found that much of the scheduled depot overhaul work was deferrable; it is now found that a large portion of this work fortunately went unaccomplished. Also, production often exceeded requirements when the latter were initially underestimated.

An analysis of the frequently large differences between desired and actual serviceable stock levels is performed. This analysis leads to a management tool, discussed in detail, which should help reduce these differences.

INTRODUCTION

In Operations Analysis Report No. 1, considerable inaccuracy was found in the setting of short-range Materiel Repair System (MRS) requirements. One salient feature of this inaccuracy was a large group of items called "infinite-quotient" items (those for which a finite requirement was set, and for which no repair was necessary at that time). For the first quarter of FY 59, 39% of all MRS items fell into the "infinite-quotient" category. It was also found that this excessive requirement occurred for items with many different characteristics. A question often raised, especially by Maintenance people, was the degree to which production followed these excessive requirements; i.e., what was the magnitude of the actual overproduction?

A second salient feature of the original study was the large degree of underestimation of requirements, particularly for tight (carcass limited) items, but sometimes also for loose items (items for which more than enough carcasses were available to bring serviceable assets up to the authorized level). Requirements for repair of the tight items were set too low on about two-thirds of the tight items, contrasted with one-fifth of the loose ones, as of the beginning of the repair quarter. The interesting question here, from a production point of view, was the degree to which production corresponded with the initial underestimated requirements on these items.

A third question of importance, somewhat separate from production, but influenced by it, is the question of the stock positions of the various line items relative to their respective authorizations. Particular interest in this subject was aroused during the study leading to OA Report No. 1, since it was

surprising that so many Hi-Valu items could be in sufficiently long supply that their reparables did not need to be put through early repair. To study their stock positions, the actual world-wide serviceable stock level was divided by the authorized stock level, and a percentage obtained for each line item. This gave us "serviceable stock quotients," the applications of which we studied.

This Supplement will examine in detail the three questions presented above, the first two in Chapter II, the final question in Chapter III.

II MRS PRODUCTION

In Operations Analysis Report No. 1, graphs were shown to portray the accuracy of requirements for a total sample of more than 600 families of interchangeable line items. The "accuracy quotient" for each item was determined by dividing the repair requirement stated at the beginning of the fiscal quarter by a criterion which indicated what the correct requirement should have been. A distribution graph was then made for all of these accuracy quotients.

A similar process has been followed for production, by dividing the actual MRS production in the first quarter of FY 59 by the same criterion; the result is termed the "production quotient." Figure 1 shows the original pattern for requirements accuracy quotients and also the newly computed production quotients.

Production on Deferrable Items

Operations Analysis Report No. 1 showed that there were many items with an infinite requirements accuracy quotient, namely, items on which requirements personnel were calling for repair which was not needed in the forthcoming quarter. We shall henceforth call such items "deferrable items." Figure 1 shows strikingly that although 39% of all items were deferrable, production was actually accomplished on only two-thirds of these items.

There was zero production accomplished on the other one-third of the deferrable items, so they migrated from the infinite requirements accuracy quotient to the .91-1.10 production quotient, since this .91-1.10 production band includes items for which the criterion said "do zero," and none were done. The lower the initial repair requirement, the more likely it was that zero production would be accomplished. This can be seen from the fairly high frequency of dots toward the left side of the zero production line in Figure 2.

FIGURE 1

Requirements and Production Quotients

All Items

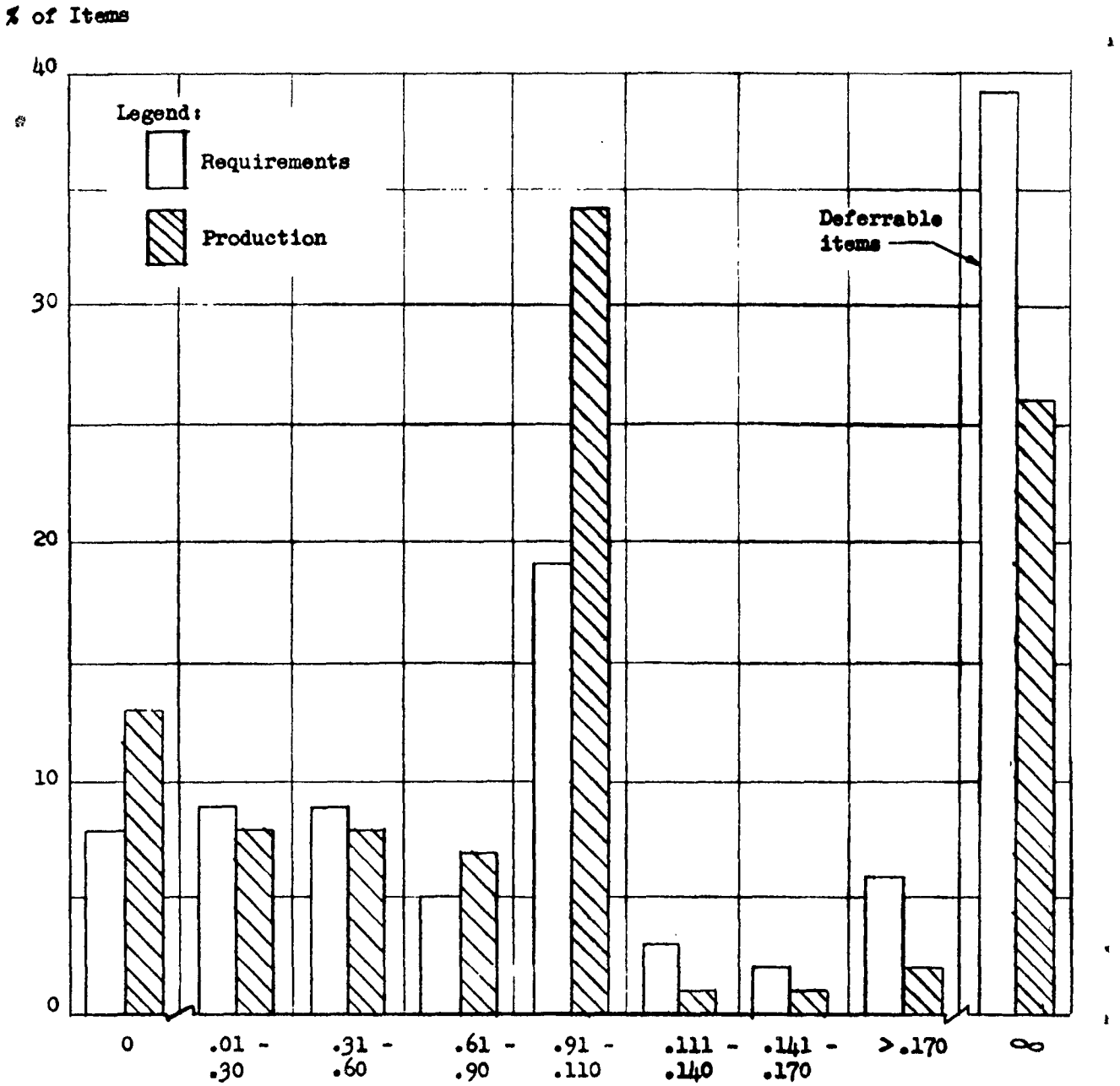
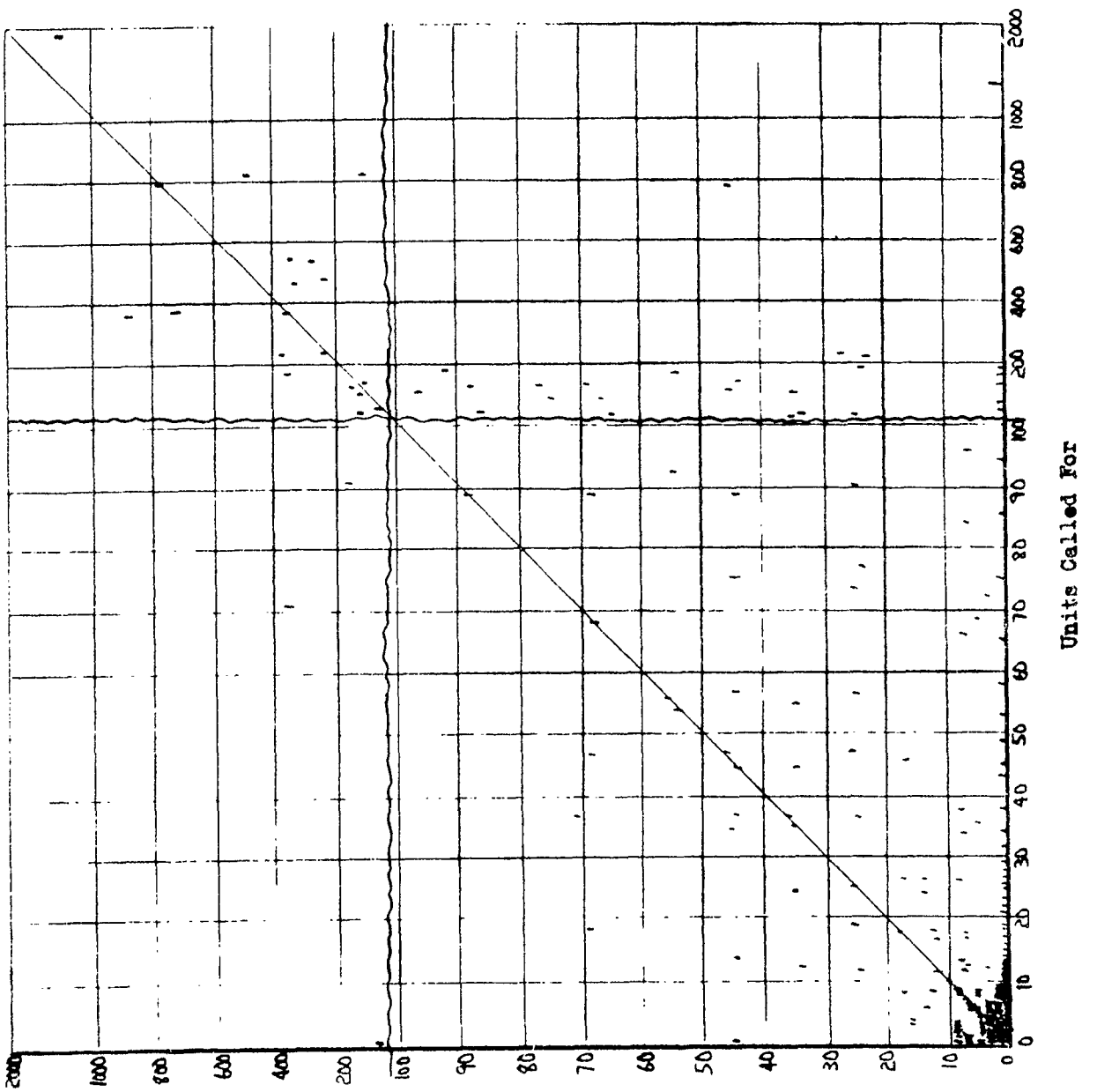


FIGURE 2

Requirements and Production On Deferrable Items*

*Items which had an infinite requirements accuracy quotient for first quarter of FY 59



Although the picture described in OA Report No. 1 is brightened considerably by lack of production on one-third of the deferrable items, a considerable portion (26%) of all items were still in the category of being not needed yet having had production. Further analysis to determine the magnitude of this production showed that Maintenance tended to produce less than the originally stated requirement for most of these items. The larger the initial repair requirement the more certain it was that some units would be produced. This can be seen from the declining frequency as we move to the right on the zero production line of Figure 2.

For appreciation of the impact on available maintenance resources resulting from this actual production of deferrable items, the following should be noted. On 31% of these items there was production of 1 to 5 units; on 43% of the items, 6 to 50 units were produced; on 17% production ranged from 51 to 200 units; and on 9% of the items, production exceeded 200 units.

Looked at in terms of manhours actually applied to MRS, our sample survey data revealed that <u>one-fourth</u> of the total MRS manhours expended were in repair of deferrable items. This suggests a considerable improvement over the picture shown in OA Report No. 1 for MRS requirements which, as originally stated, indicated that <u>one-half</u> of all the units being called for were tied to deferrable items.

In summary, it can be stated that there was a considerable amount of premature investment of maintenance resources, and related waste, but much less than would have been incurred if the initial repair requirements had been completely accomplished.

Production on Items with Underestimated Requirements

The second question to be discussed is the accomplishment of repair on items with underestimated requirements.

From Figure 3, it can be seen that Maintenance was able to produce more than the originally stated requirement on a considerable proportion (27%) of the items with underestimated requirements (namely, on items with a requirements accuracy quotient below 1.00). On 60% of the items for which production exceeded the originally stated requirement, the requirement had been raised on the Form 195 during the quarter. The fact that there was this recognition by the Commodity Class Manager (CCM) - now called Inventory Manager - of too low an initial requirement, and that Maintenance was able to respond with increased production, is a sign of good responsiveness to short range changes. In the other 40% of these items, Maintenance produced more than the original requirement without any recorded prompting from the CCM.

Although the increased production on many underestimated requirement items is a favorable sign, many cases (approximately 35%) still existed where Maintenance produced even less than an originally underestimated requirement. Because of this, the problem of underestimation was often aggravated. This fact can also be discerned from Figure 3.

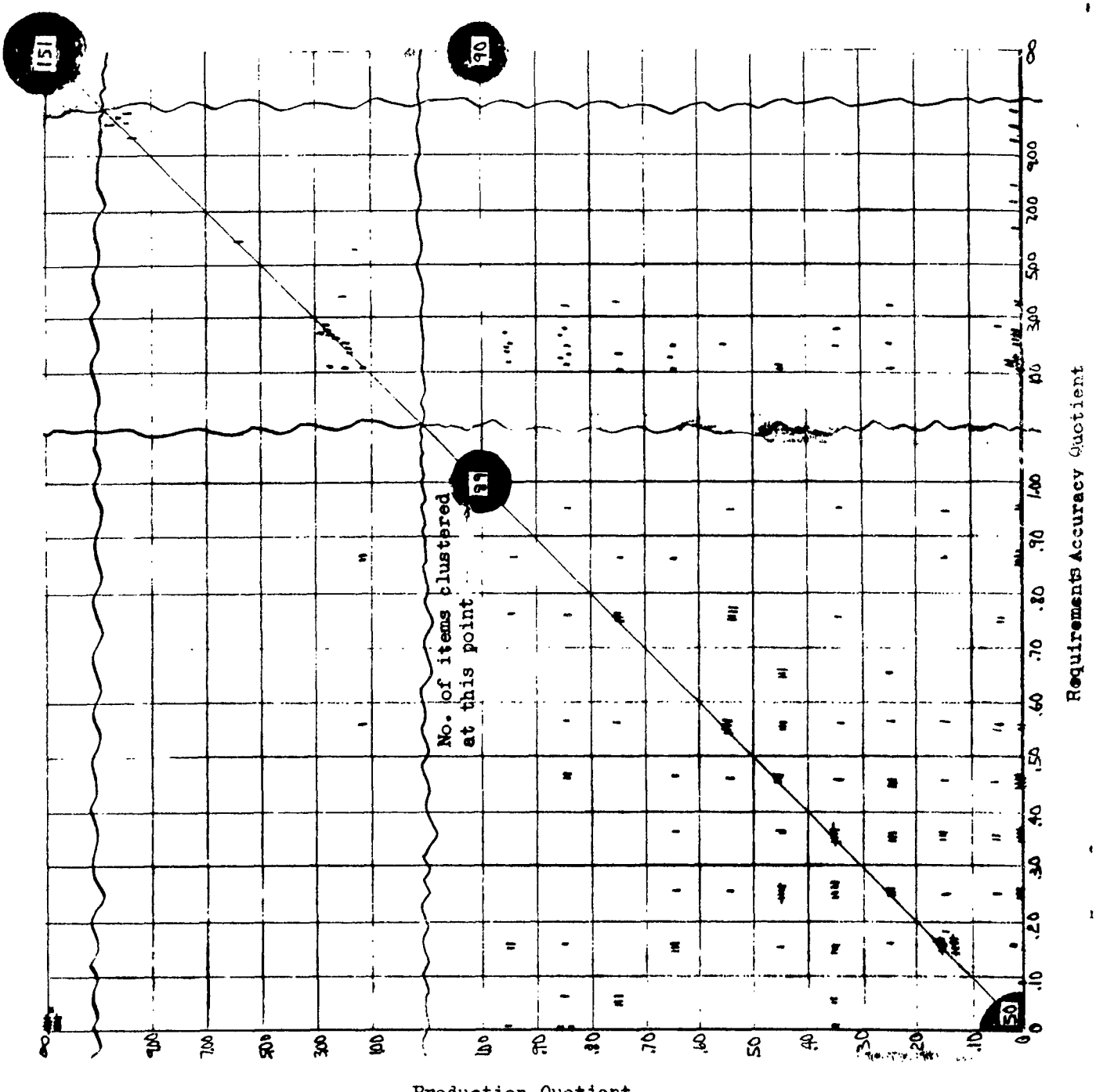
To summarize the subject of production against items which had underestimated requirements, it can be said that Maintenance could respond, and in many cases did respond in improving the situation. Many cases also existed, however, where Maintenance actually aggravated the problem.

Figure 3

Requirements and Production Quotients *

By Line Item

* Production and requirement divided by criterion, for first quarter of FY 59.



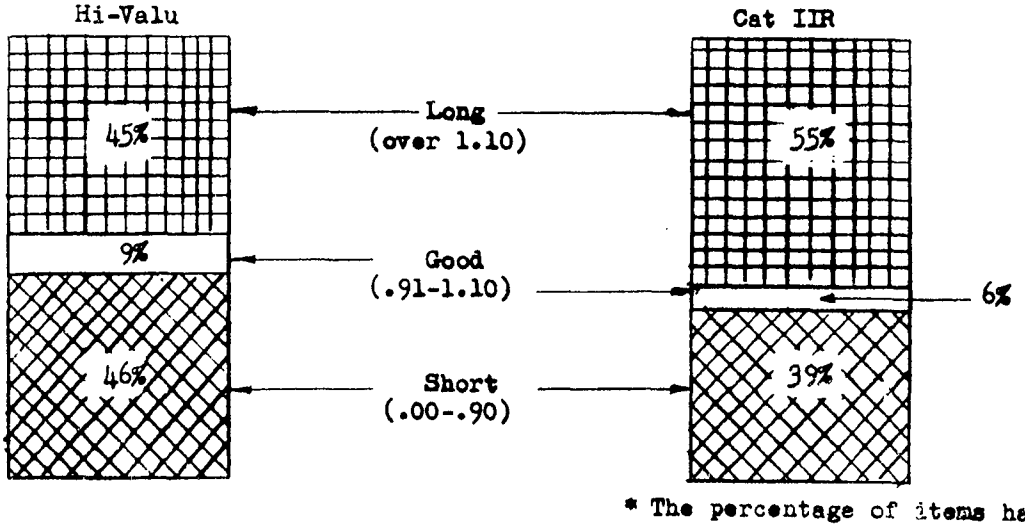
III STOCK LEVEL POSITIONS

The third question of interest in this Supplement is the relative stock position of the MRS line items. As mentioned in the Introduction to this Supplement, it seemed important to find out if many Hi-Valu line items truly had sufficient serviceables that their reparables could be allowed to remain unrepaired without loss of operational support.

To appraise stock positions, a "serviceable stock quotient" was obtained for each line item, based on actual worldwide serviceable assets, as of 31 December 1958, divided by the worldwide authorized level, as of the same date. If our provisioning and repair system had been working extremely well, we might expect that many of our items would fall within a range of .91 to 1.10 serviceable stock quotient; i.e., within plus or minus 10% of their authorized levels. By designating all items which had quotients less than .91 as "short"; items falling between .91 and 1.10 as "good"; and items having quotients greater than 1.10 as "long", we can portray this picture. It is shown in Figure 4.

FIGURE 4

Serviceable Stock Quotients *



* The percentage of items having long, good, and short serviceable stock quotients (as of 31 Dec 58).

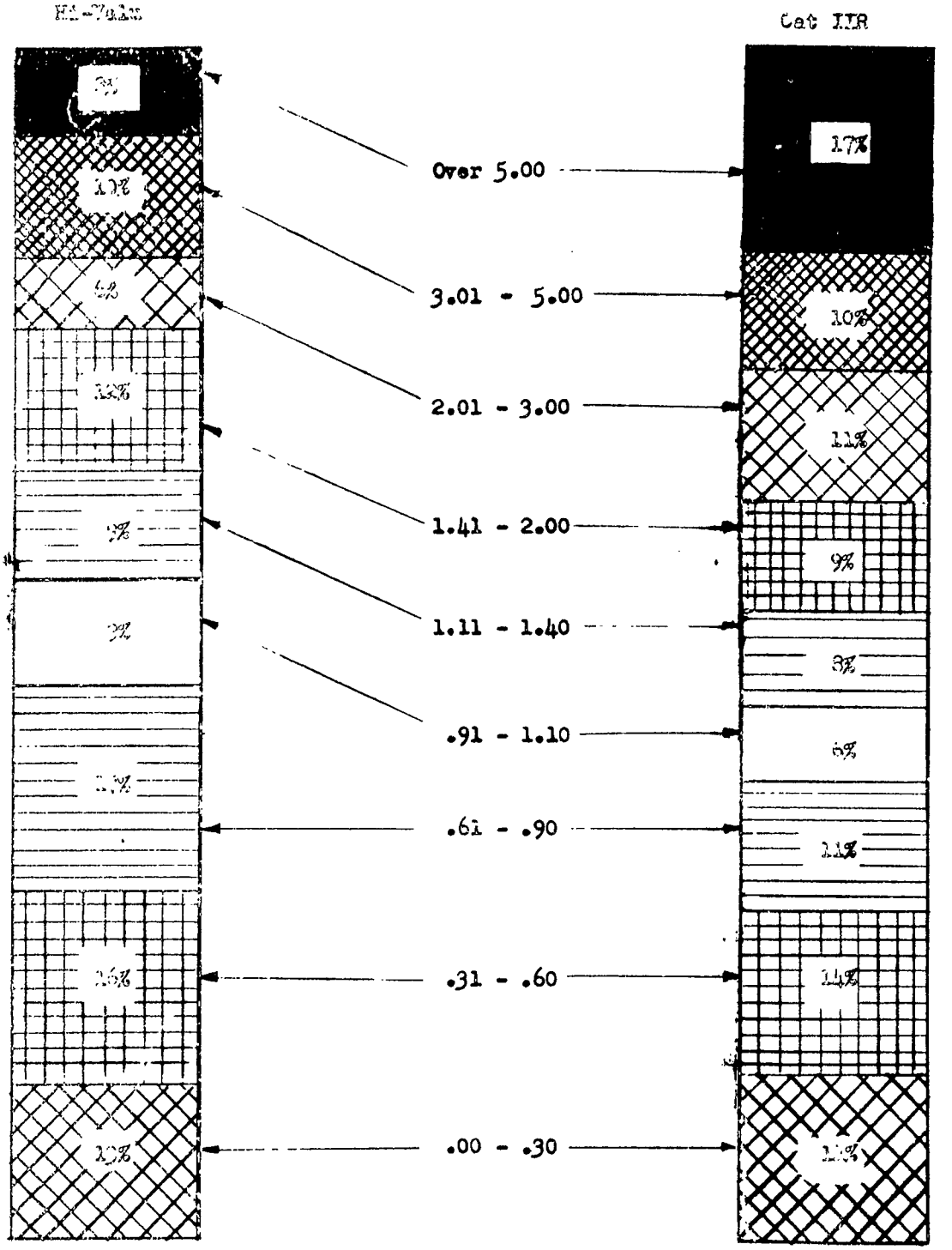
We can see that more Hi-Valu items run "short" than Cat IIR items, and that fewer Hi-Valu items are "long." Nevertheless both cost categories have many line items in long supply on serviceables, so that repair on these items can be deferred. To the extent that our logistic system uses broad policies and procedures to create a strong sense of urgency about processing and repair of Hi-Valu items, the existence of many "long" supply Cat I items becomes a potential or a threat that deferrable work will be accomplished. As a matter of fact, since the line items we are discussing are all on MRS schedules, it seems quite reasonable to note that the large number of items in "long" serviceable position may have been caused, to a substantial degree, by excess MRS production -- not excess in relation to formal MRS requirements, but excess in relation to the worldwide need for serviceables.

It is interesting to examine the stock position quotients in finer detail. If, for example, we found that serviceable stock quotients for short items were all just a little bit below .91, or for the long items were just a little greater than 1.10, the picture might look much better than it does in Figure 4. In an attempt to portray in finer detail how the quotients did fall, Figure 4 has been expanded in scale, and the "short" and "long" categories were subdivided. The results are shown in Figure 5. Our first concern over Figure 5 was whether the apparent differences between the Cat I and Cat IIR distributions might be due to chance variations of the samples used. A statistical test (the chi-square test) was run, and revealed that we can be at least 95% certain that the two distributions are truly different.

From Figure 5 we can see an indication that the more careful management given to Hi-Valu items has had a beneficial effect. Specifically, if we inquire about the proportion of items having a "desirable" serviceable position, for example within plus or minus 40% of authorized level (namely, quotients

Figure 5

Detailed Serviceable Stock Quotients



from .61 to 1.40), we find 35% of the Hi-Valu items against only 25% of the Cat IIR items. Let us try to assess whether this results from better management of the Hi-Valu items or merely from the fact that we set different authorized levels in computing their buy, and therefore use different denominators in computing the serviceable stock quotients.

Figure 6

	Cat IIR Factors	Cat I Factors	Cat I Actual (w/o Mgt)
Serviceables	600	450	225
Reparables	1200	550	775
Total	1800	1000	1000

In Figure 6 we have constructed a simple numerical illustration. We are looking at a highly predictable item with a uniform demand rate of 10 units per day, for which all reparables are sent to the depot. If we classified this item as Cat IIR, we would provide a 60 day stock of serviceables and (probably) a 120-day total repair cycle time. The same item, classified as Cat I or Hi-Valu, would be procured in sufficient quantity to allow 45 days of serviceables, ignoring WRM, and perhaps a 55 day total repair cycle. It is fairly safe to say that without the special reports, special attention and priority given to Hi-Valu items, the repair cycle could actually average close to 80 days. Using 77.5 days as the actual repair cycle, 775 units of the 1000 originally procured would be tied up as reparables, leaving only 225 units in serviceable condition. This Cat I item would then have a serviceable stock quotient of 225 ÷ 450 or .50. In other words, if demand factors are steady and accurate, Cat I items would have very low serviceable quotients without the special care and priority they receive. This line of reasoning causes us to repeat that Figure 5 does provide evidence of the beneficial results of

Hi-Valu management, since a larger percentage of Hi-Valu items are in the .61 to 1.40 range than Cat IIR.

The management benefits we have discussed have a strong tendency to increase the serviceable stock quotients for Hi-Valu items. This is laudable when the quotients would otherwise be too low -- unfortunately, it has tended to have the same effect when the quotients are already too high. Thus the Hi-Valu items in a very long supply position have tended to get the same top repair priority, being "hurried up" through repair only "to wait" for extended periods on the serviceable shelves. We shall come back to this point in a little while.

It appears to us that management should use a tool corresponding to Figure 5 on a continuing basis. Trends in the percentage of items with serviceable stock quotients between .61 and 1.40 (or something similar) should be scrutinized quarterly, and efforts made to increase this percent from the 31 Dec 58 status. Such a tool would be far more meaningful, for example, than broad brush efforts to monitor and decrease overall repair cycle time.

This leads to another enlightening aspect of Figure 5. For items in the "long" status we need actually to be striving to <u>increase</u> the repair cycle time rather than to decrease it, on the Hi-Valu as well as the Cat IIR items. That may sound like a very unorthodox approach, but it is really just another way of saying that repair work not needed in the near future should be deferred. The critical thing to remember is that such real life increases in repair cycle time must never be allowed to be reflected in the repair cycle factors used for requirements computations. When we have held reparables for long periods without repair, because they were not needed, we were compensating for an over-buy in the past; we must leave such "awaiting repair" periods out of requirements computations in order to avoid over-buys in the future.

Much attention is being given right now to the actions necessary for moving many of the long supply items out of Cat I into Cat II. It has been stated that the AMAs would conduct a more vigorous program to this end if their ratings in the Management Evaluation System (MES) depended upon it. Figure 5 could readily be adapted to this end. For example, if AMAs earned points on the basis of their trend in the percent of Hi-Valu line items within the .61 to 1.40 range of serviceable stock quotients, this would provide considerable motivation to the transfer of long supply items from Cat I to Cat II. Such a transfer of a long-supply item would automatically reduce the overly high quotient of the particular item, since the denominator of the quotient would be increased. It would (if done in volume) increase the percent of Hi-Valu items between .61 and 1.40 without necessarily reducing the percent of Cat IIR quotients between .61 and 1.40, since many of the long supply Cat I items could have the desired quotient when transformed to Cat II. This type of rating formula would simultaneously serve as strong motivation to defer that portion of MRS work which is really not needed in the near future, and to increase the emphasis on repair (or procurement) of items in short supply. It would also provide motivation for acceleration of the actual disposal of excess items, and for increased identification of excesses. It would be applicable to Cat IIR as well as Hi-Valu.

No discussion of MES rating methods can begin to be complete without consideration of the deleterious effects that may result from a rating formula. In this case it is conceivable that AMAs would be tempted to "adjust" items with poor serviceable stock quotients by changing the authorized levels so that they were closer to the actual stock positions. Whether or not this concept for a rating is worth-while depends upon an assessment of whether the AMAs could or would indulge in such a practice.

In summary of Chapter III, it can be seen that a considerable difference existed between desirable and actual stock levels. A possible management tool for examining and rating our serviceable stock positions is available, one which will lead to better asset management through examining line item stock positions. It would motivate more transfer of long-supply Hi-Valu items to Category II, more deferral of unneeded repair, more expediting of short items, and accelerated disposal of excesses.

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